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NASA TECH BRIEF

Lewis Research Center

GETTERING CAPSULE FOR REMOVING OXYGEN FROM LIQUID LITHIUM SYSTEMS

The Problem:

To remove oxygen from systems containing liquid lithium.

The Solution:

A gettering capsule consisting of a tantalum shell lined with a tantalum screen and partially filled with lithium and pieces of yttrium is immersed in the hot lithium stream. The oxygen is removed from the stream by being absorbed by the gettering capsule. The oxygen passes through the capsule wall and into the lithium inside the capsule where it reacts with the yttrium to form Y_2O_3.

How It's Done:

Oxygen in the lithium stream is quite soluble in tantalum and diffuses readily through to the lithium inside the tantalum capsule, where it forms yttrium oxide (Y_2O_3) and possibly compounds such as $Li_2Y_2O_4$. These compounds are very stable. The oxygen, a known cause of failure in liquid metal cooling systems, is thus sequestered. In turn, solid yttrium is quite insoluble in solid tantalum so the capsule wall prevents the yttrium and its oxides from entering the coolant stream where it could block the passages. Even above the melting point of yttrium, 1800 K (2780°F), tantalum metal is only slightly soluble in the liquid yttrium so that dissolution of the capsule walls should be minimal. The lithium inside the capsule, in addition to distributing the oxygen to the yttrium, serves to equalize internal and external pressures. Some void space is necessary inside the capsule because Y_2O_3 is less dense than yttrium, and also to facilitate fabrication of the capsule.

The gettering capsule as conceived is not suitable for removing gross amounts of oxygen from a system; thus the customary attention to cleanliness in construction materials and fabrication must be maintained. However, the gettering capsule has the capability to greatly extend the useful life of systems beyond that attainable with normal care. Two lithium filled heat pipes with T-111 (tantalum alloy) walls, one with a gettering capsule and one without, were tested at 1600 K (2420°F). The one without the capsule failed after 620 hours; the one with the gettering capsule is still operating after over 2000 hours of service.

Notes:

1. As cited above, the gettering capsule is designed for removing only small amounts of the order of parts per million of oxygen from liquid metal systems. The rate of removal of such oxygen has not been determined as yet, although experiments are still being conducted.
2. Liquid alkali metal cooling systems proposed for nuclear reactors and other applications may benefit from the use of this device; i.e., systems including closed loops employing forced convection, and heat pipes. Other possible applications include the removal of oxygen in laboratory purification of alkali metals. In such systems, the capsule should also serve to sequester nitrogen in the form of YN, as well as oxygen.
3. In cooling systems employing sodium, potassium, rubidium or cesium, these materials, respectively, might be employed inside the capsule in lieu of lithium. Other gettering metals might be considered if their physical and chemical properties prove suitable, including, for example, thorium, calcium, strontium, scandium, and lanthanum. Other capsule wall materials resembling tantalum in their properties might be used; for example, niobium. The tantalum screen inside the capsule can possibly be omitted on some applications.
4. No additional documentation is available. Specific questions, however, may be directed to:

   Technology Utilization Officer
   Lewis Research Center
   21000 Brookpark Road
   Cleveland, Ohio 44135
   Reference: B73-10002

(continued overleaf)

Patent Status:

Inquiries concerning rights for the commercial use of this invention should be addressed to:

NASA Patent Counsel
Mail Stop 500-113
Lewis Research Center
21000 Brookpark Road
Cleveland, Ohio 44135

Source: L.K. Tower and R. Breitwieser
Lewis Research Center
(LEW-11509)